EUROPEWAVE

ARRECIFE TRIMARAN

Iñigo Doria

CEO & Co-Founder

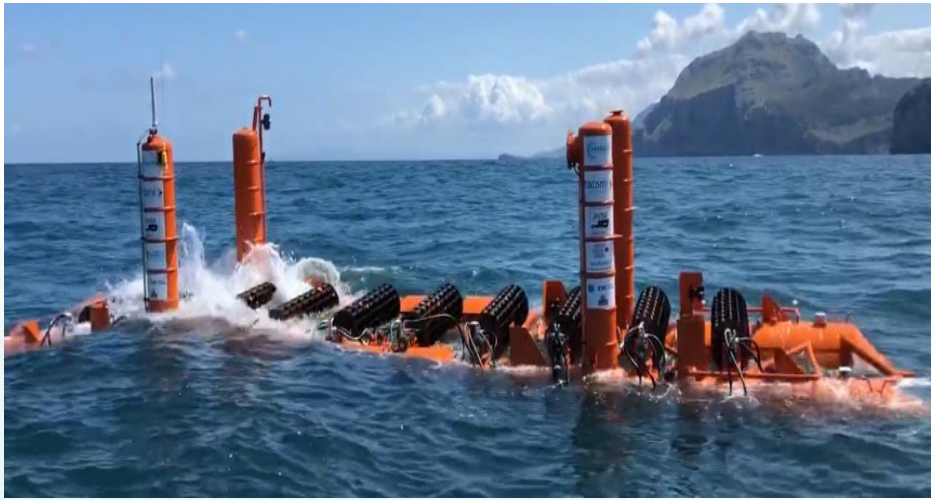
Arrecife Energy Systems

ARRECIFE energy systems

This project has received funding from the European Union's Horizon 2020 research and Innovation programme under grant agreement 883751.

Technology: inspired in coral reefs behavior

Induced ‘shoaling’ or wave breaker effect through turbines



EUROPEWAVE

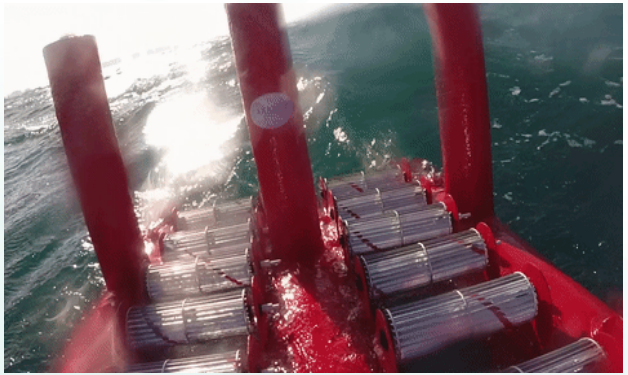
This Project has received funding from the European Union’s Horizon 2020 Research and Innovation programme under grant agreement 883751

ARRECIFE energy systems

Arrecife Trimaran key points

PRODUCTION

Shoaling effect to absorb both the potential and Kinetic energy

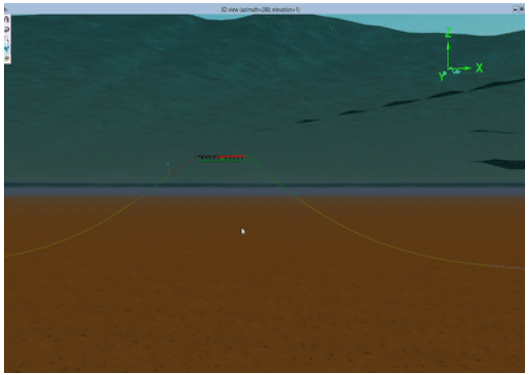


EFFICIENCY

Direct turbine-generator system

INSTALLATION COSTS

Less mooring lines to reduce costs



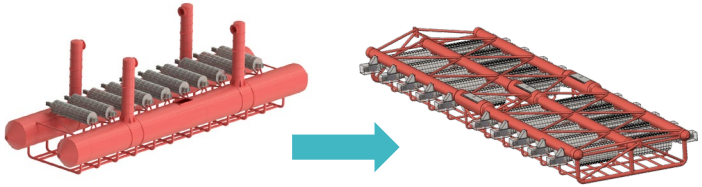
EUROPEWAVE

This Project has received funding from the European Union's Horizon 2020 Research and Innovation programme under grant agreement 883751

ARRECIFE energy systems

Phase 1. Approach

1. Redesign
   - Immersion system cancellation
   - Fixed position of the turbines
   - Catamaran to trimaran shape
   - Definition of different subsystems
   - Structural & mechanical design
   - Mooring definition & dimensioning



2. Production and efficiency
   - 1:20 scale design and definition
   - PTO definition
   - Calibration of equivalent PTO
   - Characterization of turbines
   - CFD simulations

tecnalia
MEMBER OF BASQUE RESEARCH & TECHNOLOGY ALLIANCE

3. Laboratory tests
   - Regular and irregular waves
   - Extreme waves tests
   - Self orientation

IH cantabria
INSTITUTO DE HIDRÁULICA AMBIENTAL
UNIVERSIDAD DE CANTABRIA

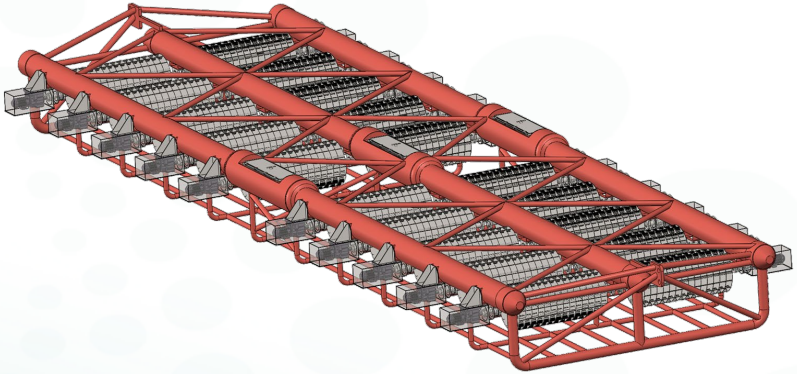
EUROPEWAVE

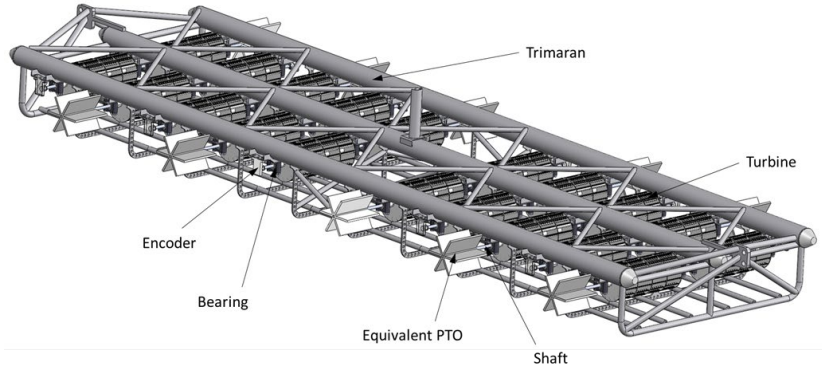
This Project has received funding from the European Union's Horizon 2020 Research and Innovation programme under grant agreement 883751

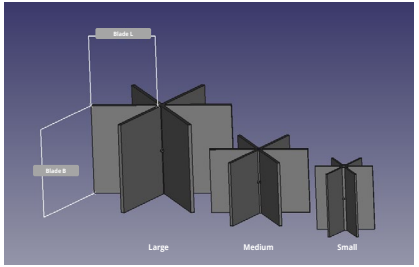
ARRECIFE energy systems

Phase 1: Power measurement challenge

Equivalent PTO for turbines-Impellers as generators







X There was no possibility to use generators on this scale

✓ Equivalent PTO: flat blade impeller – provides a resistant torque

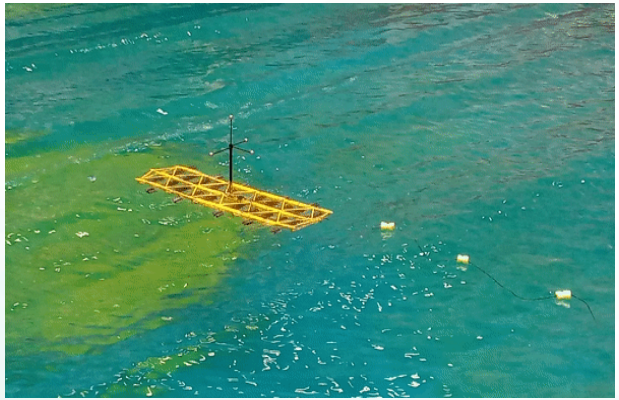
EUROPEWAVE

This Project has received funding from the European Union's Horizon 2020 Research and Innovation programme under grant agreement 883751

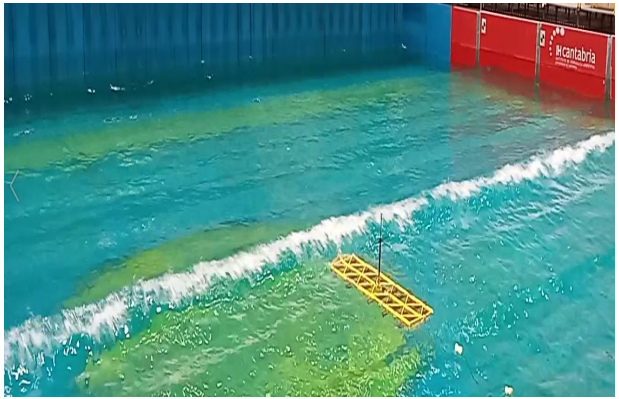
ARRECIFE energy systems

Phase 1. IH Laboratory tank tests

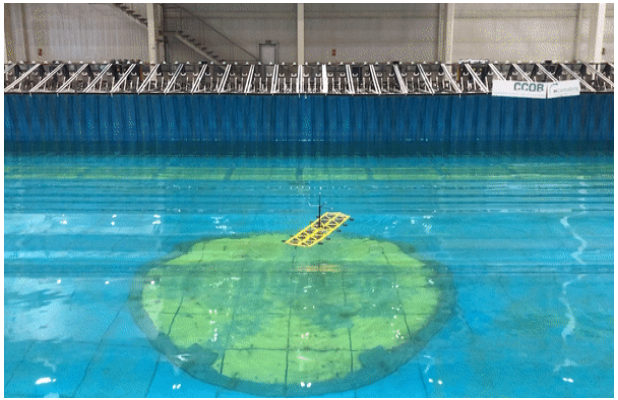
Regular & irregular tests



Extreme tests



Automatic orientation

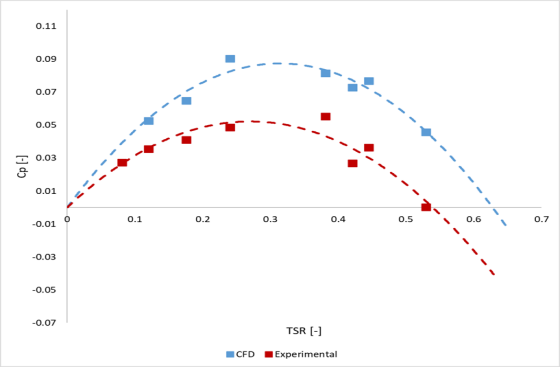


EUROPEWAVE

This Project has received funding from the European Union's Horizon 2020 Research and Innovation programme under grant agreement 883751

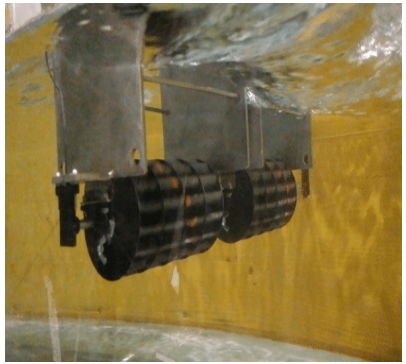
ARRECIFE energy systems

Phase 1. Conclusions and learnings



- ✓Ability to complete all the Phase 1 required tests
- ✓Correlation of CFD curves with experimental results
- ✓Turbines rotation in almost all sea states
- ✓Turbines rotation at only 0,17m/s of current
- ✓Better results with shorter periods

  Trimaran opposes water motion in surge and generates a shoaling effect
- ✓Good survivability. No issues in any of the structural parts
- ✓Self-orientation confirmation



EUROPEWAVE

This Project has received funding from the European Union's Horizon 2020 Research and Innovation programme under grant agreement 883751

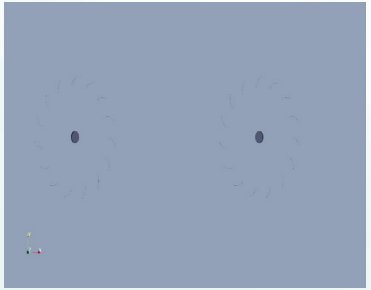
ARRECIFE energy systems

Phase 1. Conclusions and learnings

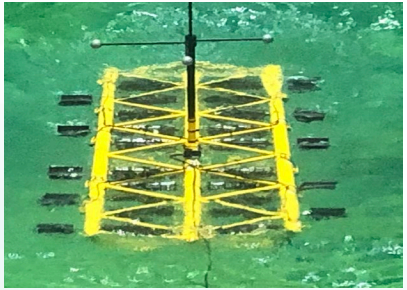
Margin for optimization in:

- Simulations. Complexity of CFDs waves models
- Tests & estimations. Impellers out of the water
- Mooring oversized (involves a cost reduction)
- Potential for better performance at longer periods
- Potential to maximize 'shoaling' effect generated

CFDs



Impellers



Mooring loads

Hs [m]	7.0	8.5
Tp [s]	12.0	16.0
LC1 [N]	12.19	10.97
LC2 [N]	12.26	10.98

EUROPEWAVE

This Project has received funding from the European Union's Horizon 2020 Research and Innovation programme under grant agreement 883751

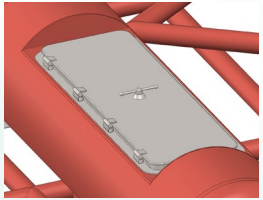
ARRECIFE energy systems

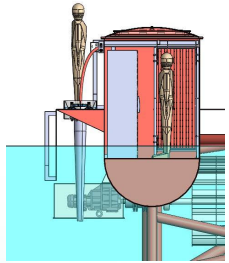
Phase 1. Conclusions and learnings

- Small-scale tests uncertainties: The simpler the better
- Complicated balance between laboratory capacity, scale and costs

  Keep in mind the capabilities of the laboratory before designing anything
- Regulation & certifications: Take them into account from the beginning
- Partners selection: know-how to avoid repeating mistakes in design and testing

Cabinets





EUROPEWAVE

This Project has received funding from the European Union's Horizon 2020 Research and Innovation programme under grant agreement 883751

ARRECIFE energy systems

Phase 2. Approach

1. Efficiency and energy production
   - Generator testing at dry test bench
   - Lab. Studies: Turbine and shoaling effect
   - Turbine performance simulations by CFD
   - Annual energy production

2. Operation and Maintenance
   - Operation and maintenance planning
   - Customized bearings
   - Waterproof generator boxes
   - Open sea corrosion studies at Harslab

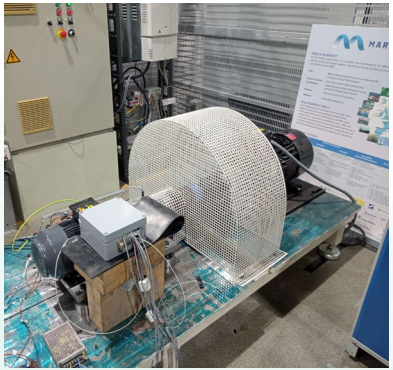
3. Structural analysis
   - Structural and mechanical analysis report
   - Mooring and connector definition

4. Electric system
   - Power electronics-Hardware architecture

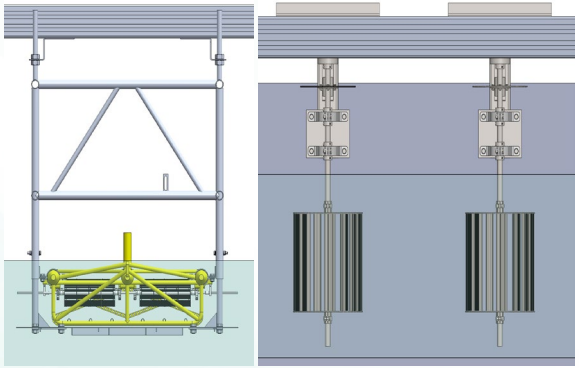
This Project has received funding from the European Union's Horizon 2020 Research and Innovation programme under grant agreement 883751

Tests we are working on

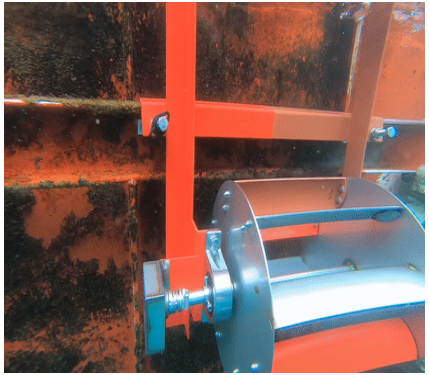
✓Generator and control strategy



✓Shoaling effect & turbine efficiency



✓Maintenance, materials and bearings



EUROPEWAVE

This Project has received funding from the European Union's Horizon 2020 Research and Innovation programme under grant agreement 883751

ARRECIFE energy systems

EUROPEWAVE

www.europewave.eu @Europewave_EU info@europewave.eu

This project has received funding from the European Union's Horizon 2020 research and Innovation programme under grant agreement 883751.